

Lead free relaxor thin films

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✚ The objective of this work is to understand the mechanism controlling dielectric relaxation behavior of lead free perovskite solid solution thin films, such as $\text{Ba}(\text{Zr}_x\text{Ti}_{1-x})\text{O}_3$ ($30.0 \leq x \leq 70.0$).

✚ The long range polarization ordering is disturbed with Zr substitution in Ti site of barium titanate (BTO) lattice to yield polar regions (Ti rich) whose sizes are reduced with the increase in Zr contents.

✚ The dielectric relaxation in these thin films is attributed to the presence of the above polar regions in a non-polar/weakly polar host. The frequency dependence of the dielectric anomaly follows Vogel-Fulcher (VF) relation indicating the interaction among these nano-polar regions followed by a cooperative freezing (at T_f) similar to that of spin-glass systems and classic complex oxide relaxor ferroelectrics (Fig.1).

✚ The existence of polar regions is ascertained on the basis of the analyses of micro-Raman spectra (Fig.2). The temperature dependent Raman spectra indicated a rhombohedral structure of these polar regions (for the above Zr contents) at 70K and no apparent structural transition was observed upon heating far above the temperature corresponding to the dielectric maxima (T_m).

✚ The understanding of dielectric relaxation behavior of such lead free relaxor thin films will be extremely useful to design novel thin films of solid solutions of ferroelectric materials with large electrostrictive coefficients and hence suitable for MEMS devices.

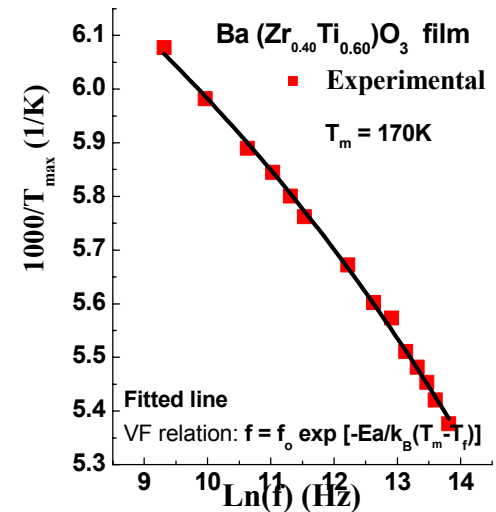


Fig.1 Fitting of the dielectric anomaly according to the VF relation

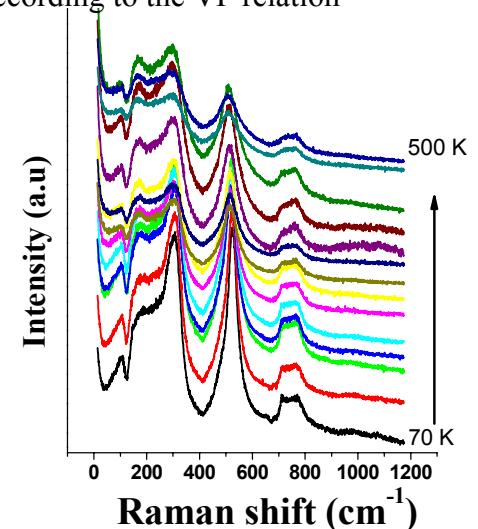


Fig.2 Absence of any structural phase transition confirms the existence of the polar nano regions far above the temperature corresponds to the dielectric maximum

Relaxor like perovskite materials for multiferroic applications

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✚ **Objective:** To synthesize and investigate systematically the ferroelectric and ferromagnetic properties of relaxor based multiferroic materials.

✚ **Requirements for multiferroic behavior:** In ABO_3 lattice: **B** magnetic cation (d^n) and **A** cation with ns^2 lone pair electrons (e.g.. $BiMnO_3$)

✚ **Material Choice:** $A(B_I B_{II})O_3$ type lattice, in which **B_I** cation with d^n configuration, **B_{II}** with d^0 configuration, and **A** with ns^2 configuration (e.g.. $Pb(Fe_{0.5}Nb_{0.5})O_3$)

✚ We have successfully synthesized phase pure $Pb(Fe_{0.5}Nb_{0.5})O_3$ with monoclinic crystal structure employing sol-gel technique.

✚ The Dielectric studies exhibited very high dielectric constant (~ 60000) at low frequencies and a diffused phase transition. The impedance spectroscopy was employed to look into the microscopic relaxation mechanism which revealed a series combination of several RC parallel circuits (of comparable relaxation times). This was indicative of the nanoscale inhomogeneity in the system

✚ The magnetic measurements exhibited a ferromagnetic behavior over a wide range of temperature from 4 K to 400 K

✚ The understanding of the magneto-electric coupling would be useful in designing novel multi-functional materials with advanced applications, such as sensors, high density memory, and spintronic devices.

